APPENDIX

Meetings

Summits

NIA Compliance

FHWA: Off-Model Air Quality Analysis – A Compendium of Practice – August 1999

ITS Strategic Deployment Plan

Division 4/ I-95 Regional Summit
March 15, 2000, 8:00 AM
MEETING SUMMARY

Attending:

Name	Agency	Phone
Curtis Andrews	Rocky Mount Planning Department	(252) 446-2331
Frank Andrews	NCDOT, Area Accident Investigation Engineer	(252) 237-6164
Captain Bagget	City of Wilson	(252) 399-2317
Darryl Best	City of Goldsboro, Planner	(919) 580-4333
Randy Black	Rocky Mount Police Department, Sergeant	(252) 972-1481
Ernest Bobbitt	City of Roanoke Rapids, Chief of Police	(252) 533-2810
Jonathan Boone	Rocky Mount, Traffic Engineer/Transp. Director	(252) 972-1121
Stuart Bourne	NCDOT, Traffic and Engineering Branch	(919) 250-4151
David Boyce	Department of Motor Vehicles Enforcement, Second Lt.	(252) 445-2122
Manny Brisile	Department of Motor Vehicles Enforcement, Captain	(919) 733-4450
Andy Brown	NCDOT, Asst. Division Traffic Engineer	(252) 237-6164
Fred Burchett	Kimley-Horn and Associates	(919) 677-2000
Pate Butler	NCDOT, Area Traffic Ops./Safety Engineer	(252) 237-6164
William Byrd	Mount Olive College, President	(919) 658-2502
Roberto Canales	NCDOT, State Construction and Materials Engineer	(919) 715-5662
Major Charlie Carden	NC Department of Motor Vehicles, Major	(919) 733-7872
Charles Chambliss	Act. Superintendent, Halifax County Schools	(252) 583-5111
Robert Cherry	Town of Tarboro, Chief of Police	(252) 641-4239
Earl Coleham	Department of Motor Vehicles Enforcement, Lieutenant	(919) 733-4430
Jeffery Dale	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151
Haywood Daughtry	NCDOT, Area Traffic Engineer	(252) 237-6164
James Dunlop	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151
Mark Dunzo	Kimley-Horn and Associates	(919) 677-2000
Don Dupree	NCDOT, Division Engineer	(252) 237-6164
Jimmy Eatmon	NCDOT, Division Ops. Engineer	(252) 237-6164
Kenn Fink	Kimley-Horn and Associates	(919) 677-2000
D. H. Garris	Wilson Police Department, Sergeant	(252) 399-2725
Ed Gauss	City of Wilson	(252) 399-2300
Joe Goodson	Town of Princeville	(252) 823-1057
Bobby Greenfield	City of Goldsboro, Fire Chief	(919) 580-4263
A. Gurley	Wayne County, Emergency Services	(919) 731-1416
James Hambright	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151
Stephanie Harris	Kimley-Horn and Associates	(919) 677-2000
Elizabeth Honeycutt	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151
Terry Hopkins	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151
Larry Jobe	Nash-Rocky Mount School, Transportation	(252) 459-5220
Gronna Jones	City of Wilson	(252) 399-2300
Tony Langston	Wilson Fire/Rescue, Division Chief/FA	(252) 399-2892
Bob League	City of Rocky Mount, Transportation Planner	(252) 972-1129
Ronald Locke	Town of Enfield, Fire Chief	(252) 445-4161
Ann Lorscheider	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151

Division 4/ I-95 Regional Summit
March 15, 2000, 8:00 AM
MEETING SUMMARY

Brian Matthews	Halifax County, Director of Planning	(252) 583-4891
Chris Miller	Miller Consulting, Owner	(252) 977-1438
Jo Ann Oerter	NCDOT, Traffic Congestion & Engineering Operations	(919) 250-4151
Thomas Parker	Wilson Fire/Rescue, Division Chief/FM	(252) 399-2881
Anna Pennisi	NCDOT, Statewide Planning (Rocky Mount)	(919) 733-4705
Jerry Pierce	City of Rocky Mount, Director of Engineering	(252) 972-1120
Charles Pittman	City of Wilson	(252) 399-2461
Wayne Sears	Rocky Mount Police Department, Lieutenant	(252) 972-1458
Raymond Smith	Goldsboro/Wayne Transit Authority, Ex. Director	(919) 731-1107
Sammy Surles	North Carolina Department of Motor Vehicles, Sergeant	(919) 733-4430
Carnell Taylor	North Carolina State Highway Patrol, First Sergeant	(252) 446-8144
AnneGayle Thomas	Halifax Community College	(252) 536-7291
Sid Tomlinson	Town of Black Creek, Fire Chief	(252) 237-6164 ext.500
Robert Treadaway	Coastal Lumber Co., Transportation Manager	(252) 536-6265
Tom Turnage	NCDOT, Division Traffic Engineer	(252) 237-6164
Inger VanOsdell	Kimley-Horn and Associates	(919) 677-2000
Peter Varney	City of Rocky Mount, Assistant City Manager	(252) 972-1325
Lynn Ward	NCDOT, District Engineer	(252) 459-2128
Michael Webb	City of Rocky Mount, Signal Systems Operator	(252) 972-1132

The ITS Strategic Deployment Plan- Division 4/ I-95 Regional Summit commenced at approximately 8:00 AM at Nash Community College in Rocky Mount, North Carolina. Following is a summary of the proceedings of this meeting.

8:00-9:00 AM Guests were registered and given the opportunity to explore demonstrations that were given on ITS technologies. Included was a demonstration of NCDOT's ncsmartlink.org traffic information web page; a presentation of web pages across the nation showing real-time traffic information, and a video demonstrating ITS applications. Coffee and doughnuts were available during this

9:00-9:15 Mr. Don Dupree, Division 4 Engineer of the North Carolina Department of Transportation, discussed the existing ITS deployments in the region and shared his vision of ITS in the region for the future.

9:15-10:00 Fred Burchett, Mark Dunzo and Stephanie Harris presented an overview of ITS that included specific technologies as well as their benefits.

10:15-11:00 Major Charlie Carden, North Carolina Department of Motor Vehicles, presented on the role of ITS for the Department of Motor Vehicles. Major Carden provided statistics on the commercial vehicle operations in the state, the related safety issues, and the opportunities ITS provides.

11:00-12:00 Breakout sessions were conducted with four groups, each one focusing on a specific topic. Groups were asked to answer/discuss a series of questions on the topics of Traffic/Incident Management, ITS for Transit, Traveler Information Systems, and Commercial Vehicle Operations. Summaries from the breakout groups are shown below.

BREAK-OUT GROUP FINDINGS

Comments provided at the session are as follow:

TRAFFIC MANAGEMENT and INCIDENT MANAGEMENT

- ITS is important to I-95
- Need more Highway Advisory Radio (HAR)
- Need information on status of railroad crossing
- School bus traffic is a problem
- Develop local area incident management plans
- Need more variable message sign's (VMS) on I-95 to provide traffic warnings and detours
- CCTV cameras and detectors on I-95 (Incident Detection)
- Detour route markings
  - Signs and information in the area of detours are often used
- Share information with bordering states about congestion, incidents or work zones
- Information should be available to local motorist for trip planning
- Regional radio broadcasts: corridor specific, especially for emergencies
- Coordination during an Incident
  - Multiple radio systems
  - Information needs to be timely
  - Need to solve personal issues when reacting to an incident
- Incident data- Where are the accidents occurring? (DMV data)
- Roadway construction information should be provided
- Issues concerning US 64 are also important
  - Red Light Enforcement for Rocky Mount
    - Left Turn Violations
- A well designed highway system and increased transit use are important issues to this region

- ITS deterrents include
  - Funding
  - "Big Brother" (rural areas)

ITS FOR TRANSIT

What are the Needs of Users?

- Existing uses of transit are in Rocky Mount, I-95 corridor and Wilson
- I-95 area public transportation under NCDOT's website
- Improved access (no interstate routes east of I-95)
- Interregional
- More fixed route transit
- Lack of rural to urban transportation availability
- Establish human relations services
- Sharing/coordination of information
- Work with businesses
  - Promote tax incentive
  - Change perception of employers that getting workers to work is the employers problem
- Need to educate the public
- Fixed route users want:
  - Reliability
  - Accessibility
  - Affordability
  - Attractiveness
  - Convenience
  - User friendly

Transportation Providers' Issues:

- Providing services to disabled people
- Local subsidy
- Money
- Lack of local support
- Balance of service to different types of riders
- Getting information out to users (website)
- Linking rural to urban

What would an ideal Transit System look like:

- Node System
  - Within the county hub
  - Cities that are within the county would be nodes
  - System would interconnect internally
  - Each County node(hub) would interconnect with each other
  - There would need to be mini-nodes to get people to main nodes

- ITS technology would be at mini-nodes in order to notify the transit system that a user is waiting for a ride
- GPS system at hubs/nodes to allow users to see where the provider is and let them determine whether they want to wait for the provider
- Common link to identify which of the provider's units are part of the master system
- 1-800 number that links to the master system
- Cost is established- cost is the same anywhere
- Regionalized system
- Inter-city bus system
- Private system to provide interconnectivity
- Comfortable system
- Flexible system
- Alternative backup system that changes with demand

What types of technology could improve transit systems?

- Call in at terminals (Demand Responsive)
- Web sites
- AVI/AVL
- Single Link/ Fare
  - SMARTCARD
- 1-800 Numbers
- GPS Software
- Communication Center
- Mobile Data Terminals

TRAVELER INFORMATION SYSTEMS

Where do you get traffic information?

- No traveler information at this time
- Use highway advisory radios to connect states for construction zones on I-95
- TV- Raleigh and Greenville
- Hard to get information with the power of radio stations that are in area
- Radio
- Internet
- Cable feeds from CCTV cameras (Rocky Mount)
- Newspapers use scanners for incident information
- Information:
  - During Floyd, paper maps were marked up as info. came into the office on road closures
- Portable Variable Message Signs (VMS)

- For detours, incidents and construction zones
- Projection (variable message signs) billboards only during the night

What traffic information do we want?

- Kiosks at rest areas and welcome centers
- Highway Advisory Radio
  - AM vs. FM- Which is better?
- Use email and telephones for road conditions (open/closed) to schools
- Overhead VMS on US and NC routes (not ONLY on interstates)
- Cost associated with deployments and available funding sources was discussed
- The use of media to disseminate information was discussed

COMMERCIAL VEHICLE OPERATIONS (CVO)

What are the Issues?

- Notification of work zones well in advance for commercial vehicle operators
- How do we get information to drivers?
  - Kiosks at truck stops
  - Coordination across state lines
  - Work zone information to dispatchers
  - Highway Advisory Radio at state lines
  - Radio Message is better for smaller companies
  - Highway Advisory Radios (AM and FM bands)
  - Rest Area locations/vacancies
  - In vehicle technology is a distraction for driver (relocate from cab)
  - Drone Radar
  - Variable message sign on DMV vehicles- IMAP truck also (receive same message as permanent VMS)
  - Black boxes in CVO
  - Better scheduling of Offloading (reduce idling while waiting)
- Website geared to motor carriers
  - Include: permits, laws maps and weather
  - Carrier profiles
- Weigh station up grades
  - Queue detection equipment
  - Weigh in motion/ CCTV/ message boards in Robeson Co. and Halifax Co. weigh stations
- Truck lane restriction issues (currently do not have)
  - Public Awareness
  - Dump truck/ rental trucks
  - Trucks on non-interstate routes

12:00-1:00 Lunch was served and Mr. Roberto Canales, P.E., State Construction and Materials Engineer for the North Carolina Department of Transportation, spoke about the measures NCDOT took during major incidents, particularly hurricane Floyd and the Blizzard of 2000 and what they learned in the process.

ACTION ITEM (S):

We would like your input on these minutes, as well as your input on the Summit in general. We will be holding more meetings across the state and would like to know your opinions of what was good, and what could be improved. You will receive mailings if additional meetings are scheduled in this area

Please direct any comments or suggestions you have for these minutes, the Summit, or additional technological solutions and barriers in this region on enclosed survey or to Kenn Fink via email at *its-I95@kimley-horn.com* ***or by phone at (919) 677-2237.***

Thank you for your input and support and your attendance.

US 70 Corridor Regional Summit
March 29, 2000, 8:00 AM
MEETING SUMMARY

Attending:

Name	**Agency**	**Phone**
Mike Addertion	Carteret County EMS, Director	(252) 728-8471
Frank Andrews	NCDOT, Area Accident Investigation Engineer	(252) 237-6164
Michael W. Avery	City of New Bern, Director of Community Development	(252) 636-4063
Joseph T. Barwick	Carteret Community College	(252) 247-6000
Captain J. Becton	City of New Bern	(252) 636-4013
Georgiana Bircher	Lower Neuse Initiative New Bern Area Chamber	(252) 637-3111
Dallas O. Blackiston	USMC, Community Plans and Liaison	
Harold Blizzard	Craven County, County Manager	(252) 636-6600
Roy Brinson	Pamlico County, County Commissioner	(252) 745-4368
Doug Case	Craven County Schools	(252) 514-6377
Adrienne Cole	Carteret County Economic Development Council, Inc.	(252) 726-7822
Jeffery Dale	NCDOT, Traffic Congestion and Engineering Operations	(919) 250-4151
Haywood Daughtry	NCDOT, Area Traffic Engineer	(252) 237-6164
Daniel T. DeBow	Craven/Pamlico/Jones Transp. Committee	(252) 637-3116
Kenn Fink	Kimley-Horn and Associates, Inc.	(919) 677-2000
Roy Fogle	Jones County Economic Development Commission	(252) 448-7571
Dennis Foster	US Forest Service	(252) 638-5628
Derryl Garner	Town of Newport, Mayor	(252) 223-4749
Donald Greenwaldt	Chief of Police, Winterville	(252) 756-1105
Thomas Greenwood	N.C. Global TransPark Commission	(252) 522-2400
Moody Gurley	LaGrange, Lenior County	(252) 566-3186
James Hambright	NCDOT, Traffic Congestion and Engineering Operations	(919) 250-4151
Steve Hamilton	NCDOT, Division Traffic Engineer	(252) 830-3490
Stephanie Harris	Kimley-Horn and Associates, Inc.	(919) 677-2000
Lauren L. Hillman	US Forest Service, District Ranger	(252) 638-5628
Nancy M. Jenkins	City of Greenville, Mayor	(252) 329-4423
Neil Lassiter	NCDOT, Division Engineer	(252) 830-3490
Floyd Lebold	River Bend	
Reggie Lee	Lenior County, Assistant County Manager	(252) 559-6405
Ann R. Lorscheider	NCDOT, Traffic Congestion and Engineering Operations	(919) 250-4151
Kelly Martin	City of Havelock, Planning Director	(252) 444-6411
Bob Mattocks	NC Board of Transportation, Member	(252) 224-8911
Kevin McKenzie	City of Havelock, Police Department	(252) 447-3212
Belayneh Mekuria	NCDOT, Traffic Engineer	(919) 733-3915
Susan Moffat-Thomas	Swiss Bear, Inc.	(252) 638-5781
Johnnie Mosley	City of Kinston, Mayor	(252) 939-3100
Cris Mowrey	North Carolina State Ports Authority	(910)343-6363
Richard Mullinax	NCDOT- Traffic Management and Signal Systems	(919) 733-3915
Tim Newton	Havelock Chamber of Commerce	(252) 447-1101
Jo Ann Oerter	NCDOT, Traffic Congestion and Engineering Operations	(919) 250-4151

US 70 Corridor Regional Summit
March 29, 2000, 8:00 AM
MEETING SUMMARY

Frank Palombo	City of New Bern, Chief of Police	(252) 672-4190
John Price	Craven Regional Airport Authority	(252) 638-8591
Lonnie E. Pridgen	Craven/Pamlico/Jones Transportation Committee	(252) 637-3116
Johnny G. Purvis	Craven County, Transportation Director	(252) 636-4917
Penny Round	Sun Journal, Reporter	(252) 638-8101
John Rouse	City of Kinston, Fleet Maintenance Supt.	(252) 939-3239
Nancy Stallings	N.C. Global TransPark Commission	(252) 522-2400
Erik Stromberg	North Carolina State Ports Authority	(910)343-6363
Garland Terry	Morehead City Police, Captain	(252) 426-3131
Scott E. Thomas	North Carolina, District 3 - NC Representative	(252) 633-6868
Thomas Tysinger	City of Greenville, Director of Public Works	(252) 329-4521
Inger VanOsdell	Kimley-Horn and Associates, Inc.	(919) 677-2000
Mike Wilson	Havelock Chamber of Commerce	(252) 447-1101
Lt. Walter Wilson	North Carolina State Highway Patrol, Lieutenant	(252) 758-5300
Daden H. Wolfe	Beaufort County, Emergency Management	(252) 946-2046
Stephen Wright	Craven County, Assistant Director, Transportation	(252) 636-4917

The ITS Strategic Deployment Plan- US 70 Corridor Regional Summit commenced at approximately 8:00 AM at The Chelsea Restaurant in New Bern, North Carolina. Following is a summary of the proceedings of this meeting.

8:00-9:00 AM Guests were registered and given the opportunity to explore demonstrations that were given on ITS technologies. Included was a demonstration of NCDOT's www.ncsmartlink.org traffic information web page; a presentation of web pages across the nation showing real-time traffic information, and a video demonstrating ITS applications. Representatives from the signals and geometrics section demonstrated the real-time computer operation of a closed loop signal system in Asheboro, North Carolina. Coffee and danishes were available during this time.

9:15-10:00 Mr. Kenn Fink, P.E., and Ms. Stephanie Harris, P.E., welcomed the guest and presented an overview of ITS that included specific technologies as well as their benefits.

10:00-11:00 Breakout sessions were conducted with two groups, each one focusing on specific topics. Groups were asked to answer/discuss a series of questions on the topics of Incident Management/Traveler Information Systems and Commercial Vehicle Operations/Traffic Management. Summaries from the breakout groups are shown below.

BREAK-OUT GROUP FINDINGS

TRAFFIC MANAGEMENT and COMMERCIAL VEHICLE OPERATIONS

Traffic Management:

- Need lanes dedicated to HOV, etc.
  - Especially on US 70
- Through traffic conflicts with local traffic
  - Access Management
  - No control of access areas
  - Emergency vehicle needs
- Signal timings need modification
  - Need for traffic response system
  - Pre-timed and time of day signals on other than major corridors need upgrades
- Military issues on US 70 and US 17
  - Peak demand and location
  - Deceleration and left turn lanes need expansion
  - Access on frontage roads
- Hurricane Evacuation
  - Local and alternate flood routes
  - Regional planning
    - Flood plains
    - Corridor preservation
    - Global Transpark/plan development
  - Evacuation
    - Timing of evacuation
    - Route 17 needs widening
- Need Regional Planning Organization
- Need to reduce crashes and increase safety
  - Investigate camera enforcement (statewide)
    - Greenville
- Stronger access management
  - Require improvements to help traffic and safety
- ITS needs to be included when development occurs
- Alternative mode of transportation
  - Need for bike lanes
  - TEA 21 allows more improvements like these
  - Bryson City Creek road
  - Bogue Banks corridor

  - Design facility/funding money needed
- Management of dissimilar vehicles
  - School buses on US 70 and other major corridors
  - Farm equipment and oversized vehicles
  - Military convoys
- Utilization of existing infrastructure
- Pay as you go
- Can ITS offset the cost of implementation
  - Benefit/cost issue
  - Signal system because ratio is approximately 18:1
- Construct roadway system for true future volumes
  - Now roads are out dated before construction
- ITS improves capacity until there are construction improvements
  - ITS is and option to construction
    - Easier and quicker to implement
- Benefits businesses until infrastructures can be in place
- Never enough money or roads
  - Rail service
  - Smarter spending
  - Improved rail crossing safety
- Need for transportation alternatives
  - Improve rail
  - Connection between modes of transportation
  - Motorist change of mindset
- Rail
  - High number of railroad crossing
    - Hard time to close crossings (crossing slows down travel time)
- Signal pre-emption
  - Used with fire, ambulance and transit
  - Takes time to re-synchronize after pre-emption takes place
  - Safety issues
- Tourism is seasonal
  - Year-round the population is 60,000 people and there are an additional 130,000 during the summer in Carteret county
  - US 70 and 24 are major routes
  - New Bern
    - ITS can provide information for the new convention center
    - Increased visitor to Tryon Palace

        - Automobile traffic
        - Parking and parking management
    - Driver behavior changes during vacation and in tourist areas
        - How to change behavior?
        - ITS provides information to people unfamiliar with the area
        - Try alternatives because some work in different areas
        - Right turn yield/rolling stops
    - Public service announcements

TRAVELER INFORMATION SYSTEMS AND TRAFFIC MANAGEMENT

- ITS to assist evacuation during hurricanes
- The NCDOT website started during Floyd needs to have more accurate; real-time information
- The NCDOT website during evacuation helps the telephone operators providing information as well as the general public
    - People had trouble getting through during Floyd
- Limited road network in division 1 and 2 for evacuation and detour routes
- Tourist traffic causes swells Friday, Saturday and Sunday
    - In peak times unfamiliar drivers saturated road network
- In-vehicle network information for those unable to access the web
- En-route technology:
    - Radio- statewide FM station providing local information
    - Dynamic Message Signs
- Competing with TIP funds is a concern- in some areas building a better road network is more important than putting technology on existing roads
- Relieving pressure from the NCDOT by using the media to disseminate accurate information
- More permanent and portable HAR to deploy during evacuations/detours to guide traffic
- How do we guide people to where they want to go?
- How do we get them home?
- Can we use money to set up a prototype traveler information system to test the effectiveness in this area?
    - Can we see real benefits from it?
- Need for a regional operation center
    - There is concern over maintenance of the deployments.
    - Will there be staff and funding in the region to operate and maintain the DMS, signal system, etc?

11:00-11:15 Break

11:15-12:00 Mr. Haywood Daughtry, III, P.E., Area Traffic Engineer for the North Carolina Department of Transportation, spoke on the US 70- reach the beach study I and II. Ms. Nancy Stallings, Executive Director for the North Carolina Global TransPark Commission, spoke on the importance of interagency communications and being proactive in transportation planning

12:00-1:00 Lunch was served and Mr. Bob Mattocks, Member of the North Carolina Board of Transportation, introduced Mr. Erik Stromberg, Executive Director for the North Carolina State Port Authority, spoke about the importance of the ports to the state, and their plans for expansion and how it affects the region

ACTION ITEM (S):

We would like your input on these minutes, as well as your input on the Summit in general. We will be holding more meetings across the state and would like to know your opinions of what was good, and what could be improved. You will receive mailings if additional meetings are scheduled in this area

Please direct any comments or suggestions you have for these minutes, the Summit, or additional technological solutions and barriers in this region on enclosed survey or to Kenn Fink via email at its-Coastal@kimley-horn.com or by phone at (919) 677-2237.

Thank you for your input and support and your attendance.

National ITS Architecture Compliance

The Statewide ITS Architecture and Strategic ITS Deployment Plan development process are both intended to be planning tools. The Strategic ITS Deployment Plan is a planning document which draws inputs from potential ITS customers throughout the State and Region. These inputs are logged and documented, then ranked to provide a snapshot of the perceived ITS needs for the next 20 years. Based on this documentation, the benefits of each project or improvement can be identified and, in turn, added to regional Transportation Improvement Plans (TIP) and the North Carolina Statewide Transportation Improvement Plan (STIP).

The development of the Statewide ITS Architecture is intended to guide the implementation process by providing a structure around which to design. ITS elements and concepts are generically named to permit a wide variety of design options, changes in technology, or institutional changes that occur over time. The intent is to provide freedom to designers and implementers by providing a stable structure for interconnection while providing flexibility to meet the unique needs of specific users.

The National ITS Architecture is divided into three levels: logical, physical and technical. The logical architecture provides a functional view of a system that assists in organizing complex entities and relationships by identifying system functions and information flows. The logical architecture guides development and deployment through functional requirements that are independent of institutions and technology. The logical architecture does not identify how each ITS function is to be implemented.

The physical architecture is the physical representation of how a system should provide the desired functionality. The physical architecture defines the information and data flows between elements and the communication requirements needed to make the system function. The data flow definitions within the physical architecture require standards to provide functionality between systems, which is the basis of the ITS standards development process.

The technical architecture is the formal design and implementation process. The technical architecture defines the implementation of the physical architecture. The technical architecture is the formal design and implementation that defines system hardware and software functionality, their interaction, and the deployment of a system that processes and distributes the gathered data.

The three levels of the National ITS Architecture work together to refine the ITS needs from the planning stage down to a specific hardware deployment. For example, the logical and physical architecture may identify the need for shared traffic information. The physical architecture would define traffic information as traffic data from detectors and video from CCTV cameras.

The purpose of this document is to develop a logical architecture for ITS deployments in the State of North Carolina. The physical architecture is part of this document, but only in describing the interaction between elements, centers, etc. The appendices document the physical architecture through the data flow diagrams and other visual methods.

This document provides the logical and physical architectures as required by FHWA and used in the long-term ITS deployment throughout the state. The details in the development of the technical architecture are left up to each entity and their designers and implementers. The logical and physical architecture layers are a tool that is to be used by the designers and implementers to ensure that data and information is shared between systems. By approaching the ITS Architecture deployment from the logical and physical levels, this document will serve as a roadmap for ITS deployments throughout the State of North Carolina for years to come without locking the State into specific technologies that may change over time.

Off-Model Air Quality Analysis: A Compendium of Practice

Federal Highway Administration
Southern Resource Center
August 1999

Introduction

Air Quality analysis methodologies have become more refined over the years to fill the need in the transportation community to satisfy various requirements including Transportation Conformity and Congestion Mitigation and Air Quality Program project justification. Off-Model methods continue to be developed and refined to allow for analysis of innovative, as well as some common, projects to account for reductions in vehicular emissions. The most typical analysis is associated with Vehicle Miles of Travel (VMT) reductions, but reductions in emissions can also occur due to decreases in vehicular delay.

This is an observation in techniques which have been used in the South to provide for the evaluation of possible emission reductions. For the purpose of this compendium, Off-Model methodologies are analyses performed without the specific use of a Travel Demand Model. As previously stated, these analyses can be used for either of two primary purposes. These two purposes are Transportation Conformity Analyses and Congestion Mitigation and Air Quality (CMAQ) Improvement Program project justifications. The later of these two is probably the most crucial given the need for project justification as a funding mechanism; however, with the increasing difficulties in showing an offset of VMT growth in most areas, any reduction will only provide a benefit to the Conformity Process.

This compendium offers a look into several methodologies utilized in Federal Highway Administration's Southern Resource Center geographic area and may be duplicated and disseminated at will. These methodologies are not all encompassing but should offer valuable insight into Off-Model practice. Updates of this compendium will occur and include any needed changes in the reference section.

If you have any questions or comments please address them to:

Andrew Edwards, Air Quality Specialist
Federal Highway Administration
Southern Resource Center
61 Forsyth St., Suite 17T26
Atlanta, GA 30303-3104
(404) 562-3673

Table of Contents

Intersection Improvements

1. General Analysis

This analysis incorporates a conservative approach to intersection improvements. It can be used for grade separation and signal timing. The conservative approach is only analyzing Volatile Organic Compound (VOC) reductions; however, NO_x may be analyzed in a similar fashion.

The analysis is as follows:

a) Calculate the existing VOC emissions.
$VOC_B = EF_B * VOL_{APP} * DIST_{APP}$

where,
VOC_B = Emissions before improvement, grams
EF_B = Emission factor (grams per mile) based on assumed speed before improvement
VOL_{APP} = Peak period approach volume
$DIST_{APP}$ = Approach distance in miles

b) Determine the average speed after the improvement.

c) Calculate the VOC emissions after the improvement.
$VOC_A = EF_A * VOL_{APP} * DIST_{APP}$

where,
VOC_A = Emissions after improvement, grams
EF_A = Emission factor (grams per mile) based on average speed after improvement

d) Calculate daily VOC emission reductions.
$VOC_R = (VOC_B - VOC_A)$

where,
VOC_R = VOC emission reductions, grams/day

2. Traffic Signal Computer Upgrade[2]

The analysis of this project was for the upgrade of computer equipment and software, cabinets and controllers, and replacement of the Communications Plant. The justification was based on an increase in the reliability of the traffic control device synchronization in the metropolitan area. This would decrease delays and reduce vehicle idle emissions. The analysis for this project was performed as follows:

a) 3-4 minutes per vehicle per direction on a major arterial with an average vehicle rate of 38,000 vehicles or 2533 hours per day was assumed to be the savings by having the more reliable system. These are the savings for a single computer section.

b) There were 60 computer sections amounting to a savings in idle time of 152,000 hours of vehicle delay per day.

c) Emission rates were established by Hillsborough County using Mobile 5a. The rates were as follows:
CO = 0.32018 kg/vehicle hour
VOC = 0.0227 kg/vehicle hour
NO_x = 0.00988 kg/vehicle hour

d) To be conservative, especially with the negative benefits which would occur for NOx with an increase in speed, emission benefits were assumed to occur only during the AM and PM peak periods (4 hours total).

e) The benefits were then calculated.
CO = (0.32018 kg/vehicle hour)(152,000 veh hrs/day)(4 pk hrs/24 hrs) = 8,111 kg/day (8.922 tons/day)

VOC = (0.0227 kg/vehicle hour)(152,000 veh hrs/day)(4 pk hrs/24 hrs) = 575 kg/day (0.632 tons/day)

NO_x = (0.00988 kg/vehicle hour)(152,000 veh hrs/day)(4 pk hrs/24 hrs) = 250 kg/day (0.275 tons/day)

Note: Delay reductions can be obtained through most intersection analysis software.

High Occupancy Vehicle (HOV) Lanes

1. General Analysis[1]

Similar to the general intersection analysis, the HOV lane analysis is again conservative with only VOC reductions accounted; however, NO_x may be analyzed in a similar fashion. This analysis also assumes that emission reductions are for the HOV lane only.

The analysis is performed as follows:

a) Calculate the existing VOC emissions.
$VOC_B = EF_B * VOL_B * DIST$

where,
VOC_B = Emissions before improvement, grams
EF_B = Emission factor (grams per mile) based on assumed speed before improvement
VOL_B = HOV Volume * Auto Occupancy of HOV / AO of Mixed Flow
DIST = HOV lane distance in miles

b) Determine the average speed after the improvement.

c) Calculate the VOC emissions after the improvement.
$VOC_A = EF_A * VOL_A * DIST$

where,
VOC_A = Emissions after improvement, grams
EF_A = Emission factor (grams per mile) based on average speed after improvement
VOL_A = HOV Volume after improvement

d) Calculate daily VOC emission reductions.
$VOC_R = (VOC_B - VOC_A)$

where,
VOC_R = VOC emission reductions, grams/day

Transit Improvements

1. General Analysis[1]

The key to Transit Improvements is increased ridership. If transit ridership goes up then Vehicle Miles of Travel (VMT) should be reduced proportionately. The approach to this analysis is trend, that is, the analysis should call on previous expansions and their effect on ridership as input into the analysis. Since this increased ridership actually decreases VMT, reductions are found for both VOCs and NO_x.

The analysis is as follows:

a) Calculate the daily VMT reduction.
VMT = (Avg. Daily Ridership After - Avg. Daily Ridership Before) / Avg. Auto Occupancy * Avg. Trip Length

b) Calculate the reduction in daily emissions.
$E_D = EF_x * VMT$

where,
E_D = Daily Emissions, grams/day
EF_x = Emission factor for pollutant x, grams/mile
VMT = vehicle mile/day

2. Express Bus Service for Broward County, Florida[3]

The analysis of this project was done to add new Express Bus Service in Broward County Florida. The basis for the project was to provide a needed service to the general public and reduce Vehicle Miles of Travel (VMT). The new transit service will operate during the morning (AM) and afternoon (PM) peaks. The AM peak will consist of three one-way trips from southwest Broward County to Downtown Fort Lauderdale with one return trip. The PM peak will consist of the reversal of the AM peak. Each peak is considered for exactly two hours (6:00AM to 8:00AM and 4:00PM to 6:00PM). The analysis for the project is as follows:

a) The Peak Hour Ridership was determined by running the FSUTMS model (Florida's Travel Demand Model). Both the AM and PM peak ridership were calculated by multiplying the peak hour ridership by 2.0 hours to yield Person Trips.
Peak Hour Ridership (from FSUTMS) = 54 Person Trips
AM Peak = 2.0 Hours * 54 = 108 Person Trips
PM Peak = 2.0 Hours * 54 = 108 Person Trips
Daily Person Trips = 108 + 108 = 216 Person Trips

b) An estimate of auto trips is found by dividing the person trips by the average auto occupancy for Home Based Work (HBW) trips.

216 Person Trips / 1.12 = 193 Auto Trips

c) An estimate of VMT is then calculated by assuming the auto trips would have taken the same trip length as the new service or 31.0 miles.
193 Auto Trips * 31.0 Miles/Trips = 5983 Daily VMT

d) The daily reduction in NO_x and VOC is found from MOBILE 5.0a using Light Duty Gas Vehicle (LDGV) emission rates. The average speed is derived from the average auto travel speed along the proposed transit route, which is 37.9 mph.
NO_x emission reduction = 5983 VMT * 1.63 g/mile * kg / 1000 g = 9.75 kg/day

VOC emission reduction = 5983 VMT * 1.25 g/mile * kg / 1000 g = 7.48 kg/day

e) The increase in VMT due to the express service is then found with the knowledge that there are four trips per peak period, again, with a distance of 31.0 miles.
Daily Transit VMT Increase = 31.0 * 8 trips/day = 248 Daily VMT

f) The daily increase in NO_x and VOC is found from MOBILE 5.0a using Heavy Duty Diesel Vehicles (HDDV) emission rates. The average speed is derived from the average bus speed along the proposed route, which is 28.7 mph.
NO_x emission increase = 248 VMT * 1.8 g/mile * kg/1000g = 0.45. kg/day
VOC emission increase = 248 VMT * 11.68 g/mile * kg/1000g = 2.90 kg/day

g) The net reduction is then found.
NO_x emission reduction = [9.75 - 2.90] kg/day = 6.85 kg/day
VOC emission reduction = [7.48 - 0.45] kg/day = 7.03 kg/day

3. Transit Centers[1]

Transit centers combine frequent bus service with park and ride (P&R) lots. The main benefit of these facilities is to reduce VMT, thus allowing for a reduction in both ozone precursors. The analysis for these facilities/projects is as follows:

a) The first step in the analysis is to estimate the number of autos removed by the new facility.
Autos Removed = Historical P&R Lot Utilization * Parking Spaces in Lot

b) Next, knowing the average peak hour speed and the average driving distance for the area emission reductions can be found. Note: Distance is multiplied by 2 to account for round trip.
Auto Emission Reduction = Autos Removed * (Avg. Driving Distance * 2) *Peak Hour Speed Emission Rate for LDGVs

c) Calculate the emissions from the increase in transit vehicles, utilizing known Avg. Driving Distance and Avg. Peak Hour Speed.
Bus Emission Increase = # of Bus Increase * (Avg. Driving Distance * 2) *Peak Hour Speed Emission Rate for HDDVs

d) The final calculation yields emission reductions in kg/day.
Daily Emission Reductions = (Auto Reductions - Bus Increase) * kg/1000g

4. Park and Ride Lots[1]

The P&R lot analysis is similar to the analysis of the transit center with the exception that increased bus service is not added. The analysis is as follows:

a) The first step in the analysis is to estimate the number of autos removed by the new facility.
Autos Removed = Historical P&R Lot Utilization * Parking Spaces in Lot

b) Next, knowing the average peak hour speed and the average driving distance for the area the total emission reductions can be found in, kg/day.
Auto Emission Reduction = Autos Removed * (Avg. Driving Distance * 2) *Peak Hour Speed Emission Rate for LDGVs * kg/1000g

Note: Distance is multiplied by 2 to account for round trip.

5. Alternative Fuel Buses[14]

Broward County, FL proposed to buy 4 alternative fuel (electric) transit buses to operate as circulators in Downtown Ft. Lauderdale. The purpose of this analysis is to demonstrate that using electric buses instead of the heavy-duty diesel buses will improve air quality.

Assumptions

- Buses will operate weekdays between 7:30 am and 5:30 pm (10 hours)
- 30 minute (0.5 hour) headway between buses per route
- Number of Daily Trips = Operation/Headway = 10 hours/0.5 hours = 20 Trips
- Average bus running speed is 14.4 mph
- Electric buses were assumed to produce zero emissions
- MOBILE model was used to obtain HDDV emission rates
- Round Trip distance is approximately 4.8 miles.

Analysis

a) Estimate emissions due to operating 4 diesel buses.

Emissions = Number of Buses * Round Trip Length * Number of Daily Trips * Emission Factor

VOCs = 4 buses * 4.8 round trip miles * 20 trips/day * 0.0030 kg/mile = 1.15 kg/day
CO = 4 buses * 4.8 round trip miles * 20 trips/day * 0.0163 kg/mile = 6.26 kg/day
NOx = 4 buses * 4.8 round trip miles * 20 trips/day * 0.0149 kg/mile = 5.72 kg/day

b) The above values reflect the emissions that would be reduced by replacement of the diesel buses with alternatively fueled buses thus showing an improvement in air quality.

6. Tampa Historic Electric Streetcar[15]

The proposed historic street car, when completed, provides intermodel connections for persons who arrive at the Convention Center or one of the hotels from Tampa International Airport and who have taken a taxi to downtown. To calculate emission benefits the following methodology was used.

a) Ridership projections were obtained from annual attendance figures estimated by the City of Tampa, Ybor City, the Port Authority, the Tampa Bay Lightning, the Florida Aquarium, and the Tampa Convention Center. Ridership figures were also based on the Memphis, TN streetcar project. The Memphis project is given reference since the attractions along the system are more relative to that of the Tampa/Ybor area. Based on the Memphis project a conservative 5% ridership at each of these venues was used for calculations. To estimate the miles saved an assumption was made that half of the estimated 5% ridership would ride the streetcar the 4.5 mile round trip between Ybor City and the Garrison Seaport District and the other half would ride shorter 2 mile trips.

	Yearly Projected Attendance	5% Ridership Assumption
Arena (Tampa Bay Lightning)	800,000	40,000
Aquarium	1,000,000	50,000
Crosstown-Ybor	1,320,000	66,000
Cruise Ships	300,000	15,000
Hogan Burke Theater	1,000,000	50,000
Hotels-Convention Center		
Convention Center	112,000	5,600
Special Events	305,000	15,250
Hyatt Regency	201,000	10,050
Local Events		
Guavaween	75,000	3,750
St. Patricks/Jose Riley	4,000	200
Gasparilla	100,000	5,000
Special Weekend	75,000	3,750
Total		264,600

b) Calculate VMT reductions.
132,300 passengers travel 2.0 miles round trip = 264,600
132,300 passengers travel 4.5 miles round trip = 595,350

Total = 859,950 miles/year = 2356 miles/day

c) Calculate emission reductions achieved from the program.

Emission Reductions = VMT * Emission Factor

VOCs = 0.0014 kg/mile * 2356 mile/day = 3.3 kg/day
CO = 0.0114 kg/mile * 2356 mile/day = 27 kg/day
NOx = 0.002 kg/mile * 2356 mile/day = 5 kg/day

7. Bus Bays on Oakland Park Boulevard[16]

Broward County proposed to build 5 transit bus-bays along Oakland Park Boulevard between Andrews Avenue and Inverrary Boulevard. Currently there are three transit routes that provide service and make frequent stops along that segment of Oakland Park Blvd. The purpose of this analysis is to demonstrate that building bus bays will improve air quality by estimating the reduction in time loss due to buses stopping to load and unload passengers. The concept is based on the reductive effects of local transit buses on the traffic carrying capacity of an arterial street. The concept in Chapter 12 of the 1994 Highway Capacity Manual (HCM) was used to estimate that reduction. For comparison purposes, traffic carrying capacity of Oakland Park Blvd. was evaluated under two conditions: one with bus bays and the other without.

In the first case, (with bus bays), buses stop in a lane that is not used by moving traffic (curb parking lane), thereby reducing the impeding effects to other traffic. The time loss to other vehicles due to bus stopping at a bus bay is estimated at 4 seconds per bus which counts for bus acceleration and deceleration time in the traffic stream.

In the second case, buses stop in the normal traffic lane impeding traffic flow and causing queuing of vehicles behind the stopped bus. The time loss in this case includes the dwell time to load and unload passengers and time loss for stopping and starting. The time loss for the lane in which the bus operates can be estimated using equation 12-3 of the HCM.

$TL = (g/c)*N*(D+L)$ where,

TL = time loss, in seconds per hour
g/c = intersection green time/cycle time ratio
N = number of buses that stop per hour
D = average dwell time, in seconds
L = additional time loss due to stopping, starting and queuing in seconds (6 to 8 seconds on average).

The analysis covers the impact of constructing five bus bays and to simplify the calculations, the reduction was estimated for one bus bay and then multiplied by five.

Assumptions

- Three bus routes operate along the subject segment of roadway
- 30 minute headway per route
- Number of buses (3*60/30) = 6 buses per hour
- Buses operate 16 hours/day average weekday
- The average speed along Oakland Park Blvd is 24.5 mph

Calculation of Loss Time with Bus Bays

The time loss is due to buses maneuvering in and out of bus bays.

Timeloss/hour = 4 seconds/bus * 6 buses/hour = 24 sec/hr

Where,

Time lost due to bus decel and accel out of bus bay, TL = 4
Number of buses per hour, N = 6
Average g/c = 0.4
Capacity of through lane = 1800 pcphpg (passenger cars per hour per green)
Capacity of one lane per hour at 0.4 g/c ratio = 1,800 * 0.4 = 720 pcphpg
Total green time available to through lanes is 0.4 * 3,600 sec/hour = 1,440 sec/hour

The percent loss in lane capacity may be expressed as:

(24 sec/hr / 1,440 sec/hour) * 100 = 1.7%

This results in a capacity loss in the right lane of 720 pcph * 0.017 = 12 pcph

Calculation of Loss Time without Bus Bays

The average dwell time using results from a field survey is 18 seconds per stop.

with,
g/c = 0.4
N = 6 buses/hr
D = 19 sec/bu
L = 6 sec/bus
TL = 0.4*6*(18+6) = 58 sec/hour

The percent loss in lane capacity is; (58/1,440)*100 = 4.03%

This results in a capacity loss in the right lane of 720 pcph * 0.0403 = 29 pcph

Emission Reduction Estimate

Net Capacity gain due to building Bus Bays = 29 - 12 = 17 pcph

The distance of the highway impacted by each bus bay is 500 feet

Net VMT gained by installing Bus Bays = (500 ft/ 5280 ft/mile) * (17 pcph * 16 hours/day)
= 26 mile/day

The average travel speed is 24.5 mph

VOCs = 26 mile/day * 2.31 g/mile * kg/1000g * 5 locations = 0.30 kg/day
CO = 26 mile/day * 20.31 g/mile * kg/1000g * 5 locations = 2.64 kg/day
NOx = 26 mile/day * 2.48 g/mile * kg/1000g * 5 locations = 0.32 kg/day

Vanpool Programs

1. General Analysis

Vanpools achieve emission benefits by reducing vehicle trips. Average commute distance is doubled to simulate a round trip. Average ridership should be based on historical vanpool size data obtained from the Metropolitan Planning Organization (MPO). The analysis is performed as follows:

a) Calculate vehicles removed by the vanpool.
VMT removed = Historical Vanpool Size / Avg. Vehicle Occupancy

b) Calculate the Daily Emission Reduction achieved by the reduced VMT, kg/day.
ER = VMT removed * Avg. Commute Length * 2 * Peak Hour Speed Emission Rate (LDGV) for Pollutant * kg/1000g

2. Dade County, Florida Vanpool Program[4]

The Dade County Vanpool Program provided 30 vans to qualified participants. Air quality benefits are achieved through the reduction in VMT associated with the reduction of individual commuters. The increase in vehicles due to the vans provides a somewhat negative offset of these benefits. The analysis consists of five steps.

1) Estimate the number of autos removed from the roadway by the vanpool program.
2) Calculate the Daily VMT eliminated.
3) Calculate the emission reductions due to the decrease in VMT.
4) Calculate the addition emissions generated by the new service.
5) Derive the Net Benefits from the Program.

The following provides an example.

a) Reduction in Automobile use is calculated by knowing the amount of seating and the average area auto occupancy. The total seating provided by the vanpool is 345 seats, divided into vans with capacities of 15 and 8 passengers. The average auto occupancy of Dade County is 1.22 persons per automobile. The calculation is as follows:
Autos Eliminated = Vanpool Seats / Auto Occupancy = 345 Seats / 1.22 Persons / Auto = 283 Autos

b) VMT reduction is calculated through the knowledge of average round trip commuter distance for Dade County.
VMT Reduction = Autos Eliminated * Average Commute Distance = 283 Autos * 21.8 Miles / Auto = 6169 Miles

c) Emission Reductions are found by using the appropriate emission rate for LDGVs.
The Average operating speed for Dade County is 27 mph.
Emission Reduction = Emission Rate * VMT * kg/1000g
Emission Reduction = 81.49 kg/day CO; = 10.49 kg/day VOC; = 10.12 kg/day NO_x

d) Emission increases, due to the implementation of the new vehicles, are calculated knowing the emission rate for Light Duty Gas Trucks (LDGTs) and the VMT for the fleet. The VMT is derived from the fleet size and the average Dade commute distance, previously noted, or 654 VMT.
Emission Reduction = Emission Rate * VMT * kg/1000g
Emission Reduction = 10.63 kg/day CO; = 1.33 kg/day VOC; = 1.22 kg/day NO_x

e) The Net Air Quality difference is thus a product of the Reductions calculated in step c) subtracted by the Increases in emissions calculated in step d).
CO = 70.86 kg/day
VOC = 9.16 kg/day
NO_x = 8.90 kg/day

Other Off-Model Methodologies

1. Incident Management[1]

The main goal of an Incident Management Program is to reduce congestion by removing vehicles which are debilitated, injured or just broke. Nonrecurring Congestion is the effect these vehicles have on the main line flow. Excess freeway emission are caused by this type of congestion. This analysis provides the basis for calculation of reduction of VOCs due to these programs; however, NO_x can be analyzed in a similar fashion.

a) Determine Regional Freeway VOC Emissions, E_B.

b) Determine Freeway Emissions due to Nonrecurring Congestion, E_C.
$E_C = E_B * 0.049$

Note: 4.9 Percent of Freeway Emissions are Caused by Nonrecurring Congestion.[5]

c) Next the Daily VOC reductions, E_D, are calculated. These assume, since freeway emissions are directly related to VMT, that the VMT in the program area is used to calculate emission reductions.
$E_D = L * VOL_i * E_C / VOL_T * EFF$

where,
L = Length of Freeway
VOL_i = Volume of Freeway i
VOL_T = Regional Freeway VMT
EFF = Project Effectiveness, 50% for Incident Detection and Response, 25% for Motorist Assistance, and 15% for Surveillance.

2. Pedestrian / Bikeway - General[1]

The main goal of bicycle and pedestrian facilities is to provide other transportation options for a community. The air quality benefits, as with most projects, come with a reduction in VMT. The general calculation for these projects is shown below.

a) First, calculate the Daily VMT reduction.
VMT Reduction = PD * Area * L * BMS

where,
PD = Population density of location, persons/mile^2
Area = Project length * 1 mile radius, mile^2
L = Round trip length, one-half of the project length times 2 daily trips, miles
BMS = Bike mode share, %

b) Last, calculate the Daily Emission reductions for a pollutant.
$E_D = EF_x$ * VMT Reduction

where,
E_D = Daily Emissions, grams/day
EF_x = Emission factor for pollutant x, grams/mile
VMT = vehicle mile/day

3. Bikeways - General

Little data is available on the utilization of bikeways; however, if such data is available it can prove invaluable in providing mode shift data to predict VMT reduction. The following is an analysis which shows how to calculate emission reductions if a history of mode shift percentage is known.

a) First Calculate daily VMT reduction provided by mode shift in the corridor.
VMT Reduction = AADT in the corridor * PMS

where,
PMS = historical percentage of mode shift for area

b) Last, calculate the Daily Emission reductions for a pollutant.
$E_D = EF_x$ * VMT Reduction

where,
E_D = Daily Emissions, grams/day
EF_x = Emission factor for pollutant x, grams/mile
VMT = vehicle mile/day

4. Sidewalks Near Schools in Farragut, Tennessee[6]

This project connected and extended previously constructed sidewalks along the parental responsibility zone of the Farragut schools. This analysis assumes a minimum usage increase of 10%, with a VMT reduction of 2 miles on arterials and 5 miles on local roads. There are 5,602 students in Farragut schools. It should be noted that students walking remove 4 vehicle trips. The analysis is as follows:

a) Since VMT is reduced on both arterials and local roads, there are two VMT reduction calculations.
Students with Travel Mode Change = 5602 *.10 = 560
VMT Reduction (Arterials) = 560 Persons * 2 Miles / Person = 1120
VMT Reduction (Local) = 560 Persons * 5 Miles / Person = 2800

b) Knowing the Average Speed for the given roadway classification emission factors are generated for both VOC and NO_x by roadway classification.
VOC Reduction = (1120 VMT * .00194 kg/mile) + (2800 VMT * .00227 kg/mile) = 8.6 kg/day

NO_x Reduction = (1120 VMT * .0022 kg/mile) + (2800 VMT * .0019 kg/mile) = 7.8 kg/day

5. <u>I/M Compliance Changes, Texas</u>[1]

Procedures leading to a higher compliance rate for a I/M program benefit air quality by detecting then repairing faulty emission control systems. The Texas Air Control Board was asked to supply projected compliance rates for changes to our current I/M system. Current compliance rates for each county are available from TACB. Emission benefits are calculated with the following equations:

a) The first step is to calculate the emission rates before and after a change in compliance rates, g/day.
Improved Emissions = Projected I/M compliance * AADT * 24hr Avg. Speed Emissions
Previous Emissions = Current I/M compliance * AADT * 24hr Avg. Speed Emissions

b) The final step is to calculate the Daily Emission benefit due to the increased compliance rate, kg/day.
Daily Reductions = (Improved Emissions - Previous Emissions) * kg/1000g

6. Travel Demand Management (TDM), Public Education Campaign, Pinellas County, Florida

The purpose of this project was to provide intermodal transportation information via several programs within a public education campaign to promote a shift from the use of single occupant vehicles (SOV) to alternatives such as bicycle, public transportation, and ridesharing. By educating the public to these transportation options and their cost effectiveness, a substantial number of vehicles could be eliminated from the roadway, thus reducing VMT.

a) The first step in the analysis is to combine the knowledge of Work Trips for the area with the Trip Rate. Pinellas County has an estimated employment of 377,312. Knowing the Home Based Work Trip Rate is 1.8, provided by the FSUTMS model, Daily work trips can be calculated.

Daily Work Trips = Total Employment * Trip Rate = 377,312 * 1.8 = 679,162 Trips

b) The 1991 Tampa Bay Regional Survey conducted by Florida Department of Transportation provided Trip Length Distribution information. This survey showed the Mean Trip Length was 26.6 minutes, reflecting travel time and terminal times. Using an average area speed of 19.6 mph the Average Trip Length can be calculated.

Average Trip Length = Average Travel Speed * Mean Trip Length * hr / 60min = 19.6 miles/hr * 26.6 min * hr / 60min = 8.68 miles

c) Next the VMT reduction can be found with the knowledge of the Daily Work Trips and Average Trip Length.

Work VMT Reduced = 679,162 * 8.68 miles = 5,895,123

d) Based on a study conducted by STAPPA/ALAPCO an estimated percent reduction in work travel VMT was found to be 0.5 %.[8] Therefore, the VMT Reduction due to the implementation of the Public Education Campaign is:

VMT Reduction = 5,895,123 * 0.5 = 29,476

e) The final step is to calculate the emission reductions using MOBILE emission factors for the known Average Speed of 19.6 mph.

Emission Reduction = VMT * Emission Factor (g/mile) * kg/1000g
VOC Reduction = 29,476 * 2.36 g/mile * kg/1000g = 69.6 kg/day
NO_x Reduction = 29,476 * 2.46 g/mile * kg/1000g = 72.5 kg/day
CO Reduction = 29,476 * 20.38 g/mile * kg/1000g = 600.7 kg/day

7. Ramp Metering[9]

Project/Policy Description

Ramp metering is a common form of urban traffic control. It aims to reduce or eliminate operational problems resulting from freeway congestion by restricting flow to the freeway mainline. With mainline demand restricted to less than the available capacity, ramp metering tends to maintain uninterrupted, non-congested flow on the freeway. By smoothing vehicle flow, ramp metering aids in utilizing the existing freeway capacity and also reduces the probability of accidents at merge locations.

The total change in vehicle emissions due to ramp metering can be broken down into 3 elements: travel changes on the mainline, travel changes on the arterial street system, and changes in operating conditions on the ramp. All three elements are affected by the changes in traffic volumes resulting from ramp metering, including increased traffic volumes on the arterial street system. Emissions on the ramp change because of the changes in the way the ramp is operating. Ramp metering results in greater vehicle idling and greater acceleration on the ramp then is experienced without ramp metering. The travel demand forecasting model accounts for emissions resulting before the implementation of ramp metering. Therefore, the change in emissions before and after ramp metering is calculated in this analysis so that the difference can be applied to the total regional emissions from the travel demand forecasting model.

Assumptions

1) Vehicles entering at on-ramps are not experiencing delay before the implementation of ramp metering.
2) Emissions associated with the change in acceleration/deceleration on the ramps are negligible compared to emissions resulting from the increases in travel speeds on the freeway mainline.
3) Ramps are only metered until the maximum storage capacity of the ramp is met. After that time, ramp metering is turned off.
4) Queuing emissions on the ramp include that emission of the vehicle traveling on the ramp at low speeds.
5) No consideration was given to concurrent use of HOV facilities in the ramp metering corridor.

Emissions Analysis

a) Determine the freeway limits and time period for the ramp metering. Considerations for the implementing ramp metering are discussed in the *Manual on Uniform Traffic Control Devices* and the NCHRP Report 232, *Guidelines for Selection of Ramp Control Systems,* Page 52. The Florida DOT used freeway volume after the merge point and speed to determine if ramp metering was warranted as documented in the *Southeast Florida Intelligent Corridor System Ramp Metering Analysis.*

b) Obtain volumes (HPMS adjusted), capacities, and speeds of travel demand network links for all freeways, ramps, arterial cross streets and parallel cross streets which will be affected by ramp metering.

c) Calculate total emissions before ramp metering for the time period when ramp metering will be implemented (such as the peak period):

$\text{Total Emissions} = 3\ (\text{LENGTH}_i \times \#\text{VEHICLES}_i \times \text{EMISSIONS RATE}_i)$

where,
$i = 1$ to n, and n is the number of links

d) Determine ramps to be metered and their associated storage capacity and metering rates. Ramp metering rates can be determined by first calculating the reduction in demand required to result in the desired mainline operating condition. After the mainline difference is calculated, the difference is distributed between the upstream ramps. The metering rate will be dependent on the required reduction, the demand at the particular on-ramp and the storage capacity of the ramp.
The recommended minimum metering rate is 300 vehicle per hour (for a one-lane ramp), and the recommended maximum is 900 vehicles per hour (for a one lane ramp).[10]

e) Calculate total ramp delay and the maximum individual waiting time due to the implementation of ramp metering. These can be calculated using basic queuing diagrams of number of vehicle accumulated over time (see example in Figure 1).

f) Estimate the diversion of vehicles to the parallel arterial. The number of vehicles diverting will be a function of trip length, queue length, ramp delay, and the availability and efficiency of alternate routes.[11]

g)Adjust volume/capacity ratios for all links as needed to account for ramp metering (queuing on the ramp) and diversion.

h) Calculate new freeway, cross street arterial and parallel arterial speeds using the travel demand model volume/delay curves.

i) Calculate after metering emissions based on new link volumes, capacities and speeds. Freeway and arterial link emissions can be calculated as described in step 3.

j) For the on-ramps, calculate queuing emissions as follows:
Total Emissions = Total Delay x Emissions $\text{Rate}_{\text{Idling}}$

k) Calculate the difference between before metering and after metering emissions.

l) Calculate emission differences for all peak periods which are metered.

m) Apply the total difference in emissions for all peak periods to the total emissions calculated from the travel demand model output (total emissions before metering).

Caveats

1) The congestion mitigation benefits of ramp metering are conservative since the methodology is based on average annual daily traffic and no incident delay is incorporated into the analysis. Ramp metering will reduce incidents at the freeway merge and the associated vehicle delay.

2) The emissions estimate assumes that there will be no change in demand as a result of the ramp metering. The same number of vehicle trips will be made although they may be diverted to the arterial street systems. The methodology does not take into consideration latent demand that may be generated with better operations on the freeway; in the forecast years, this will be less critical due to the fact that demand will probably greatly exceed capacity.

8. University North Commuter Center[13]

The University North Commuter Center will offer information and related services to promote greater use of a range of commuter alternatives to SOV travel, including public transit, ridesharing, bicycling, walking, telecommuting and others. Services include a staffed information center, located at the University Mall, a transportable kiosk for special events within University North, a "Virtual Commuter Center" web page, and covered bicycle storage units available to participating employment sites. The analysis is as follows:

a) Estimate the number of users/participants, users. 400 new users.

b) Estimate gross vehicle trip reduction (VTR) based on mode shifts. Gross one-way vehicle trips reduced = users * mode Trip Reduction Factor (TRF).

	Users	TRF	Daily Trips	Gross Trips Reduced
New Carpooler	210	0.5	2	210
New Vanpooler	10	0.9	2	18
New Transit User	100	1	2	200
New Bicyclist	50	1	2	100
New Walker	20	1	2	40
New Telecommuter	10	1	2	20
New Compressed Work Week	0	1	2	0
New Satellite Work Center User	0	0	2	0

Total Gross Trips Reduced = 588

c) Fraction of users or participants using prior HOV and/or SOV access, in percent.

HOV% = 10.0

d) Determine net VTR. Net Vehicle One-way trips reduced = Gross VTR * (1 - HOV%/100)

Net VTR = 588 * (1 - 10/100) = 529.2

e) Determine vehicle miles of travel reducted (VMT). Average one way trip length = 11 miles/trip.

Reduced VMT = Net VTR * Average Trip Length = 529.2 * 11 = 5821.2

f) Determine daily emissions reduced. Daily Emissions Reduced = Emission Factor * Reduced VMT
CO Reduced = 5821.2 mile/day * 0.0114 kg/mile = 66.4 kg/day
NOx Reduced = 5821.2 mile/day * 0.0020 kg/mile = 11.6 kg/day
VOC Reduced = 5821.2 mile/day * 0.0014 kg/mile = 8.1 kg/day

9. Qualitative Analysis - Intermodal Transit Links[12]

Project Description

The study will examine transit system connections withing the Downtown and a Historic Area that will coordinate with other transportation components such as parking and bicycle / pedestrian facilities.

Purpose

The proposed CMAQ grant will fund a study which examines opportunities to improve the efficiency of transportation services in the Downtown and a Historic area. This project will examine optimal transfer of locations for intermodal connections between all modes of transportation including an electric streetcar, future rail transit, buses, bicyclists, pedestrians, and automobiles. Parking availability and opportunities will also be analyzed.

Project Justification

Effective intermodal connections are essential to an efficient transportation system. This study will identify optimum locations for intermodal transfers to reduce vehicular congestion, idle times in buses and automobiles, and overlapping transit service. In addition this analysis will identify ways to improve service and public use for through trips and intermodal connections by improving or streamlining routes and improving and adjusting headways. The air quality benefits derived from this project are difficult to quantify. However, for the purposes of this analysis, it is assumed that efficient intermodal connections will achieve a substantial reduction in the overall mobile source emissions in the study area for several reasons.

C Increased transit ridership attributed to better connectivity
C Amenities for pedestrians and cyclists (information kiosks, bike racks, shelters)
C Increased use of non-motorized travel
C Less vehicle idle times waiting for connections
C Reduced, shorter internal trips, less cold starts

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